Paper 116: Scalable ROS-Based Architecture to Merge Multi-source Lane Detection Algorithms

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1. Introduction

ATLASCAR Project

ATLASCAR1 (Ford Escort 1998)

ATLASCAR2 (Mitsubishi i-MiEV 2015)
1. Introduction

- Data from the LIDAR (Light Detection And Ranging) is not sufficient for the perception of road boundaries;
- Detection of road lines/boundary is one of the most important domains of autonomous driving;
- There are several algorithms for detection of limits/road lines, however, there is not one that individually satisfies all situations.
2. Proposed Approach

a. Parametrization of detection algorithms

Input: image from a single camera or multiple cameras

Output:
- Polygon of the road lane
- Lines delimiting the lane

Multiple types of road lane detectors

All algorithms’ outputs have to be on the same data type
2. Proposed Approach

b. Combination of multiple algorithms from a single camera
2. Proposed Approach

1. Blur Filtering

\[ I \]

\[ F = \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix} \]

\[ G = F \otimes I \]
2. Proposed Approach

2. Shifting

\[ L = L_C \times N \]

\[ L_C = \frac{\text{ceil} \left( \frac{\text{side}(f_s)}{2} \right)}{f_s} \times \alpha \]
2. Proposed Approach

3. Final Confidence Map

\[ I \]

\[ L = L_C \times N \]

\[ M \]
2. Proposed Approach

c. Combination of several cameras, each with one or two algorithms

1. IPM (Inverse Perspective Mapping) technique to transform the polygons into the same frame;

2. Combination of the warped polygons through the logic operations “AND” and “XOR”;

3. Confidence maps of each camera are weighted summed.
3. Experimental Infrastructure

a. Hardware

2 Cameras
Point Grey FL3-GE-28S4-C:
- Resolution: 964 × 724
- FPS: 15

Fixation and protection cameras system
3. Experimental Infrastructure

b. Software

- Flycap
  - Define “frame rate”
  - Define resolution

- pointgrey_camera_driver
  - ROS messages
3. Experimental Infrastructure

b. Software - Processor Algorithm based on Classical Techniques

- **Warp Transformation**: Transformation of the image perspective (similar technique to IPM).
- **Lines Segmentation**: Combination of two techniques: “Colour Selection” e “Edge Detection”.
- **Curve Fitting**: 2nd degree polynomial approximation in order to obtain the curve.
- **Final Image**: Final representation of the road lane line.
3. Experimental Infrastructure

b. Software - Processor Algorithm based on Deep Learning Techniques

- Semantic Segmentation;
- CamVid dataset;
- 11 Classes;
- Encoder-Decoder.
4. Experiments and Results

Validate/comprove:

- Utility;
- Scalability;
- Reliability.

Experiments:

1. 1 single camera + 2 algorithms
2. 2 cameras + 2 algorithms

360 assessed frames
4. Experiments and Results

Indices:

\[
I_1 = \frac{WCA}{A_T}
\]

\[
I_2 = \frac{A_C}{A_T}
\]
4. Experiments and Results

1 single camera + 2 algorithms

(a) Variation of the indices (%).

(b) Standard deviation values.
4. Experiments and Results

2 cameras + 2 algorithms

(a) Variation of the indices (%).

(b) Standard deviation values.
5. Conclusions

- More robust detect road maps than by using the algorithms individually;
- Two types of output representations are converted into an unique representation to allow the merging procedures;
- Valid approach to merge traditional computer vision techniques and DL based classifiers;
- Valid approach to combine multiple source road detection algorithms;
- Next step: migrate into a unified representation, probably based in occupancy grids, to merge data from different sources (LIDAR and cameras).
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